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Differences in horizontal and vertical mismatches across countries and fields of study

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Abstract. *Based on early career data on graduates in Europe and Japan, the authors investigate whether full job mismatch (i.e. field-of-study mismatch and over-education), mere horizontal mismatch and mere vertical mismatch can be explained by differences in institutions and labour market imbalances. Mere horizontal mismatch is lower in countries with stronger employment protection, higher unemployment benefits and selective educational programmes. Cross-country differences in mere vertical mismatch are largely explained by labour market imbalances. These variables also affect full mismatch, which is positively related to collective bargaining coverage as well. Field-of-study differences in mismatches are similarly determined by educational programme characteristics and labour market imbalances.*

The (mis)match between education and work has been the focus of considerable research, concentrating primarily on vertical mismatch or over-education (Groot and Maassen van den Brink, 2000; McGuinness, 2006). Recently, however, more interest has been shown in so-called horizontal mismatch as well – that is, mismatch between a worker's field of study and the content of his/her job (Wolbers, 2003; Robst, 2007). The bulk of the existing literature focuses on the effects of mismatch, typically finding that mismatches are harmful in terms of wages and worker well-being (Hartog, 2000; Allen and van der Velden, 2001). There is also substantial evidence that the incidence

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of mismatch varies widely, not only across individuals, but also across labour market segments by field of study and across countries.

At the micro level, research indicates that a variety of factors are responsible for these inequalities, including lower-quality human capital, job search constraints and discrimination (McGuinness, 2006). At more aggregated levels, a frequently suggested cause is imbalance between demand and supply. At the macro level, the massive expansion of higher education that has occurred in many countries is often held responsible; at the meso level, the higher incidence of mismatch among workers with a humanities degree than among those with technical degrees suggests that students fail to choose fields of study that are in demand because of technological developments. However, whether such imbalances can truly explain the variability of mismatch at more aggregate levels largely remains to be investigated.

A small but growing body of research has begun to address this question through cross-country comparisons of the incidence of over-education. In an early contribution, Groot and Maassen van den Brink (2000) rely on meta-analysis to explain over-education at the macro level. They find that its incidence is positively related to the growth of the labour force. Another study, by Di Pietro (2002), uses data from a panel of European countries to show that differences in over-education across countries are related to the educational composition of the labour force, the strictness of employment protection legislation (EPL) and the level of R&D investment.

More recently, Verhaest and van der Velden (2013) investigated country and field-of-study differences in over-education among European graduates. Their results show that demand and supply conditions within the labour market as well as the institutional setting matter. First, they find evidence regarding the impact of structural imbalances between the demand for and supply of educated workers on the incidence of graduate over-education in a country. The supply of educated workers is not found to be important in itself, indicating that supply may create "its own demand". Further, business cycle conditions at the time of labour market entry also contribute to explaining graduate over-education. With respect to educational institutions, Verhaest and van der Velden show that not only the orientation of the study programme (general versus specialized) but also its quality and selectivity are important in explaining country and field-of-study differences in over-education. Finally, with respect to labour market institutions, their research finds no evidence that EPL influences over-education. Similar conclusions regarding the role of structural imbalances, the business cycle and EPL are set forth by Croce and Ghignoni (2012), who rely on data for the full labour force. Finally, Davia, McGuinness and O'Connell's (2010) analysis confirms the aforementioned conclusions regarding structural imbalances in the quantity of skilled labour and the selectivity of the educational system. In addition, they find over-education to be more prevalent among countries with low union density.

In this article, we build on the existing literature by investigating the determinants of differences in mismatch across countries and fields of study five

years after graduation. Our analysis contributes to the literature in four ways. First, we extend the analysis to horizontal mismatches. Apart from Wolbers (2003), who finds a positive correlation between the incidence of horizontal mismatches and unemployment, few studies have investigated cross-country differences in this type of mismatch. Moreover, no country-level studies have investigated horizontal and vertical mismatches simultaneously. Some research shows that a combination of over-education and field-of-study mismatch is particularly harmful to wages and job satisfaction (see Robst, 2008; Béduwé and Giret, 2011). However, there is no evidence of a wage penalty for a mere field-of-study mismatch, without over-education. It would thus appear that field-of-study mismatch is less problematic for individuals, perhaps because it also indicates that workers are employable in a wide range of occupations. It is therefore important to determine whether different combinations of horizontal and vertical mismatch are driven by different underlying mechanisms.

Second, the present study takes account of differences in union bargaining coverage, rather than union density. The abovementioned finding that unionized countries have a lower incidence of over-education seems to contradict the widespread assumption that more rigid wage formation impedes labour market clearing. However, union density is only loosely correlated with the impact that unions actually have on the bargaining process. Union bargaining coverage is therefore likely to be a better indicator of wage rigidity.

Third, our study considers the role of unemployment benefit policies. We hypothesize that countries with more generous unemployment benefits face lower levels of mismatch. And fourth, we investigate much more deeply the factors that explain differences in mismatches between fields of study. The lower incidence of mismatch generally observed among individuals with a technical degree (in comparison to those with a humanities degree) may indeed be explained by technological change. An alternative explanation, however, may be that study programmes differ across fields of study in terms of quality or selectivity and the extent to which they are vocationally versus generally oriented. We disentangle the effect of differences in study programme characteristics from the effect of structural imbalances between the demand for and supply of field-of-study-specific labour.

For these analyses, we use REFLEX and HEGESCO data on graduates in 17 European countries and Japan. We apply multilevel analysis and consider a three-level nested structure: the individual level, the field-of-study level and the country level. We estimate a multinomial logit model with four outcome categories: "full match" (reference), "mere vertical mismatch" (only vertical but not horizontal), "mere horizontal mismatch" (only horizontal but not vertical) and "full mismatch" (both vertical and horizontal).

The remainder of the article is structured as follows. First, we develop our theoretical framework and hypotheses. Next, we explain our methodology, then give an overview of our results. Finally, we discuss our findings and offer conclusions.

Theoretical framework and hypotheses

Demand and supply context

A first potential source of cross-country differences in mismatches is variation in the extent to which there is an overall imbalance between the demand for and supply of skilled workers, either structurally or cyclically. There are two theoretical effects, which sometimes oppose each other (Bowlus, 1995). On the one hand, an oversupply of skilled workers may force jobseekers to accept jobs below their level of education and/or outside their field of study. On the other hand, oversupply allows employers to be more discriminating. Employers may prefer more highly educated, and thus over-educated individuals (cf. Thurow, 1975; Okun, 1981), as well as individuals with the correct field of study (cf. Bowlus, 1995). This means that graduates with an "incorrect" field of study are forced to remain unemployed. An oversupply of skilled workers will thus lead to more over-education, while the impact on horizontal mismatch is theoretically ambiguous. Several studies have shown that a structural oversupply of skilled workers does indeed result in more over-education (see Davia, McGuinness and O'Connell, 2010; Ghignoni, 2011; Croce and Ghignoni, 2012; Verhaest and van der Velden, 2013). Moreover, Croce and Ghignoni find that, at the country level, the business cycle also affects the overall incidence of over-education. Similarly, Verhaest and van der Velden (2013) find that the business cycle in the year of labour market entry explains cross-country differences in over-education up to five years after graduation; graduates have difficulty finding a vertically matched job during an economic downturn. Only Wolbers (2003) investigates cross-country differences in horizontal mismatches; he finds that a high unemployment rate in the year of labour market entry increases the likelihood of horizontal mismatch. Based on our theoretical considerations, we expect that the latter largely results from the increased likelihood of a full mismatch. We therefore test the following hypotheses:

Hypothesis 1: Countries with a structural oversupply (undersupply) of skilled workers face a higher (lower) incidence of mere vertical and full mismatch;

Hypothesis 2: Countries in a recession (economic boom) at the time graduates enter the labour market have a higher (lower) incidence of mere vertical and full mismatch.

Imbalances between supply and demand in terms of fields of study are also likely to explain mismatches. Individuals who face fierce competition for jobs within their field-of-study segment of the labour market may be forced to accept jobs in other field-of-study segments with labour shortages or in labour market segments at lower skill levels. Evidence for this hypothesis is provided by Wieling and Borghans (2001), who show that a supply surplus for an educational type results in a higher percentage of over-educated graduates. More indirect evidence that educational mismatches result from imbalances in terms of fields of study is the finding that a graduate's field of study is a strong pre-

dictor of whether he or she is likely to be over-educated or horizontally mismatched (see Dolton and Silles, 2003; Wolbers, 2003; Frenette, 2004; Ghignoni and Verashchagina, 2014). It is often reported such mismatches are relatively infrequent among graduates in technical fields of study, and relatively frequent among those with a humanities or arts degree. A first cursory reason for this finding is that the differences in mismatch do indeed result from purely quantitative imbalances. Most countries have a relatively low share of graduates choosing technical fields of study by comparison with humanities and arts (Oosterbeek and Webbink, 1997). Moreover, skill-biased technological change and the increasing importance of innovation may have further increased the demand for engineers and computer scientists. A second interpretation, however, is that differences in mismatch across fields of study are related to more qualitative differences between fields of study. Technical fields of study typically feature more specialized programmes (Wolbers, 2003) and are typically more selective (Rochat and Demeulemeester, 2001) than programmes in the arts or humanities. We therefore test whether the differences in mismatch persist even after accounting for differences in study programme characteristics, such as orientation (general versus specialized), quality and selectivity.

Hypothesis 3: Graduates with a technical degree are, irrespective of the orientation, quality and selectivity of their programme, less likely to experience any type of mismatch.

Hypothesis 4: Graduates with a humanities or arts degree are, irrespective of the orientation, quality and selectivity of their programme, more likely to experience any type of mismatch.

Educational institutions

With respect to the role of these study programme characteristics, we differentiate between within- and between-country effects. At the country level, we expect a negative relationship between the quality and selectivity of the educational system and the hiring standards adopted by employers (cf. Green, McIntosh and Vignoles, 2002). Accordingly, a high level of study programme selectivity and quality at the country level will be associated with a lower amount of formal over-education. Further, we expect that a high level of selectivity and quality is also associated with a lower prevalence of horizontal mismatches. In a country with a low level of programme selectivity and quality, employers must rely more on additional training. Consequently, hiring employees whose field of study matches their job becomes less important. Within countries and fields of study, we expect that graduates of study programmes that are less challenging and selective will be more inclined to accept any type of mismatch, since those graduates are likely to receive fewer suitable job offers. Employers confronted with graduates from a low-quality study programme will be inclined to hire an over-educated one, but not necessarily one with a mere horizontal mismatch. Thus the within-country effect that study programme selectivity and quality has on vertical mismatch is straightforward:

the higher the selectivity and quality of the programme, the lower the chance of vertical or full mismatch. For mere horizontal mismatches, however, the within-country effect of the quality and selectivity of the study programme has a theoretically ambiguous sign. The negative relationship between the quality and selectivity of a study programme and the incidence of vertical mismatch is well established empirically, both within countries (Robst, 1995; McGuinness, 2003; Di Pietro and Cutillo, 2006) and between countries (Davia, McGuinness and O'Connell, 2010; Verhaest and van der Velden, 2013). Research regarding the impact of the quality and selectivity of the study programme on horizontal mismatch, however, is lacking. We thus test the following hypotheses:

Hypothesis 5: Countries with a more selective and higher-quality educational system have a lower incidence of any type of mismatch.

Hypothesis 6: Within countries, graduates from a more selective and higher-quality study programme are less likely to expereince a mere vertical or full mismatch.

As regards study-programme orientation (general versus specialized), we primarily expect an impact on horizontal mismatches. General study programmes offer a wider array of skills that can be used across occupations. When employed in jobs for which they are horizontally mismatched, graduates from this type of programme will be relatively more productive than graduates from a specialized study programme. Conversely, those with a more specialized study programme will be relatively more productive in the case of a horizontal match (Wolbers, 2003). Further, general programmes usually focus more on learning and analytical skills and less on directly applicable skills. Hence, even if graduates of a general study programme manage to find a job that matches their field of study, they are more often required to start in a lower-level job to gain some practical work experience before being promoted to a higher position (see Sicherman and Galor, 1990). Moreover, given that general degrees provide less clear signals about the occupation-specific skills of graduates, employers may use lower-level jobs as a screening device for the higher-level jobs (see Ghignoni and Verashchagina, 2014). The effect that study-programme orientation has on mere vertical mismatch is thus likely to be stronger for graduates who recently entered the labour force than for graduates who finished their programme five years ago. Nevertheless, Verhaest and van der Velden (2013) find that the effect of the study programme's orientation on over-education remains significantly positive five years after graduation. This is likely explained by the fact that graduates of these programmes face a higher likelihood of full mismatch. Hence:

Hypothesis 7: Countries with a more generally oriented educational system have a higher incidence of mere horizontal and full mismatch among graduates five years after their graduation.

Hypothesis 8: Within countries, individuals with a more generally oriented study programme are more likely to experience a mere horizontal or full mismatch five years after finishing their programme.

Labour market institutions

Labour market institutions also deliver a potential explanation for differences in mismatch across countries. First, we investigate the role of EPL, which reduces employers' ability to replace badly matched employees with well-matched jobseekers. Employers are likely to anticipate these problems. A job candidate's level of education and field of study provide signals to employers regarding the candidate's level and type of ability and talent. Since the employment of an individual with the "wrong" field of study carries a huge risk in terms of productivity losses, we expect that employers will not be inclined to hire these kinds of jobseekers if firing costs are high. Furthermore, one may expect that employers in countries with strong EPL rely more on internal promotion to place employees in the right kind of job. In these countries, we thus expect higher levels of over-education among newcomers to the labour market. As stated in our introduction, the evidence from Di Pietro (2002), Croce and Ghignoni (2012) and Verhaest and van der Velden (2013) regarding the impact that EPL has on over-education is inconclusive. One potential issue is that none of these studies differentiates between merely vertically mismatched individuals and those who are fully mismatched. We thus form the following hypothesis:

Hypothesis 9: Countries with a higher level of employment protection face a lower incidence of mere horizontal mismatch and a higher incidence of mere vertical mismatch.

Second, differences in unemployment benefit regimes may also explain cross-country differences in mismatch. More generous unemployment benefits allow jobseekers to be more selective, resulting in fewer mismatches. While the analysis by Croce and Ghignoni (2012) does not confirm this, their analysis is based on data for the full labour force. Given that unemployment is generally higher among young individuals, the unemployment benefit regime may be a more important factor for the sample that is investigated in our study. Hence the following hypothesis:

Hypothesis 10: Countries with more generous unemployment benefits have a lower incidence of any type of mismatch.

Finally, we investigate the role of collective bargaining coverage as an indicator of wage rigidity.[1] As McGuinness (2006) argues, wage rigidity impedes market clearing, resulting in more mismatches. Croce and Ghignoni (2012) also point to another effect resulting from the impact that relative wages have on the opportunity cost of mismatches (see also Gottschalk and Hansen, 2003). This effect may work in two directions. On the one hand, unions may bargain for above-competitive wages for high-skilled jobs, resulting in increased opportunity costs of over-education. On the other hand, unions may have a preference for wage compression and bargain for above-competitive wages

[1] Collective bargaining coverage is an indicator of the extent to which the terms of workers' employment are influenced by collective bargaining.

for low-skilled jobs, resulting in decreased opportunity costs. Croce and Ghignoni provide evidence that the latter mechanism dominates. They show that the relative wages of tertiary education graduates have a negative impact on the incidence of over-education, while relative wages are in turn found to be negatively affected by union bargaining coverage. This conclusion seems to conflict with the results of Davia, McGuinness and O'Connell (2010), who find that higher union density may result in lower levels of over-education. However, as previously stated, union density is an imperfect measure of unions' influence on the bargaining process. Accordingly, we hypothesize that collective bargaining coverage has a positive effect on mere vertical and full mismatch.[2] Regarding the impact of collective bargaining coverage on mere horizontal mismatch, similar mechanisms can be considered. On the one hand, flexible wages may help labour market clearing, thus reducing the incidence of mismatch. On the other hand, flexible wages may facilitate the assignment of individuals to the occupations most in demand on the labour market, even if those jobseekers do not have a matching field of study. The overall effect is thus theoretically ambiguous. Given that previous empirical evidence is lacking, we therefore do not formulate a hypothesis regarding this type of mismatch and confine ourselves to the following:

Hypothesis 11: Countries with higher collective bargaining coverage have a higher incidence of mere vertical mismatch and full mismatch.

Methodology

Data and mismatch measurement

Our analysis is based on data from the REFLEX and HEGESCO surveys. The REFLEX survey was conducted among graduates in 15 countries, namely: Austria, Belgium (Flanders), the Czech Republic, Estonia, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Switzerland and the United Kingdom.[3] The survey was conducted in 2005 using a representative sample of graduates of higher education programmes who received their degrees in academic year 1999–2000. HEGESCO is a related survey that was carried out in 2008 among individuals who graduated in academic year 2002–03 in Hungary, Lithuania, Poland, Slovakia and Turkey. The data include detailed information about each respondent's study programme, first employment after graduation and employment at the time of the survey (see Allen

[2] An alternative approach may be to include relative wages and to use collective bargaining coverage as an instrumental variable to account for endogeneity, following Croce and Ghignoni (2012). However, comparative data on wages for lower segments by field of study are lacking. Moreover, applying an instrumental variable approach within a multilevel multinomial logit model would significantly complicate estimation. Therefore, we elect to estimate a reduced-form specification in which collective bargaining coverage is directly included.

[3] Sweden also took part in the REFLEX project, but using a different experimental design; the Swedish data are therefore not comparable.

and van der Velden, 2011). We exclude Lithuania and Turkey from our analysis, because not all aggregate indicators used in this study are available for those two countries. Further, we focus on individuals who were employed five years after their graduation and exclude those who had engaged in post-graduate studies. Finally, in order to avoid over-representation of certain countries, we confine the sample of our multivariate analysis to a maximum of 2,000 randomly chosen cases per country. Omitting observations with missing values leaves a final sample of 14,398 individuals.

To determine the match status, we rely on self-assessments. To identify vertical mismatches, respondents were asked: "What type of education do you feel was most appropriate for this work?" The graduates could choose between a number of (sub)levels of education. When the appropriate level, as assessed by the respondent, is lower than the graduate's educational attainment, he/she is considered to be over-educated. To simplify the analysis, the under-educated are grouped with individuals whose level of education matched the type they reported as being the most appropriate.[4] Horizontal mismatch was identified using the following question: "What field of study do you feel was most appropriate for this work?". Here, respondents could choose between: (1) exclusively own field, (2) own or a related field, (3) a completely different field, or (4) no particular field. The first two answers are understood as a horizontal match, and the last two, as a horizontal mismatch. By combining the two types of mismatches, we obtain the four (mis)match categories defined previously.

Table 1 reports the incidence of the different types of mismatch by country for respondents' jobs five years after graduation. On average, countries had a nearly identical incidence of full mismatch and mere vertical mismatch – each at 8 per cent. The average incidence of mere horizontal mismatch is somewhat higher – just over 10 per cent. However, these numbers differ substantially across countries. On the one hand, countries like Portugal, Norway, Finland, France, Switzerland and Slovenia each have an overall mismatch incidence of less than 20 per cent. On the other hand, countries like the United Kingdom, Hungary, Spain, Poland and particularly Japan show a substantially higher incidence of mismatch. There are also substantial differences across countries in the distribution of the incidence of the three types of mismatch. Some countries had a relatively high incidence of one type of mismatch, but a relatively low incidence of another. Japan, for instance, exhibits a very high incidence of mere horizontal and full mismatch, but a rather low incidence of mere vertical mismatch. Similarly, Estonia faces a relatively high incidence of mere horizontal mismatch and a relatively low incidence of mere vertical mismatch. Unlike Japan, however, Estonia's incidence of full mismatch is relatively low.

[4] This decision is justified by the finding that the earnings and job satisfaction of under-educated individuals is typically at least as high as that of adequately educated individuals (see Hartog, 2000; Verhaest and Omey, 2009).

Table 1. The incidence of mismatch five years after graduation

	Full match	Mere vertical mismatch	Mere horizontal mismatch	Full mismatch
Portugal	0.855	0.079	0.040	0.026
Norway	0.829	0.105	0.022	0.043
Finland	0.829	0.073	0.060	0.037
France	0.805	0.061	0.084	0.051
Switzerland	0.804	0.071	0.071	0.054
Slovenia	0.803	0.078	0.065	0.054
Germany	0.793	0.086	0.066	0.055
Belgium	0.777	0.082	0.069	0.073
Estonia	0.776	0.049	0.156	0.019
Czech Republic	0.768	0.064	0.114	0.054
Netherlands	0.761	0.057	0.124	0.057
Austria	0.752	0.070	0.118	0.060
Italy	0.724	0.119	0.074	0.084
Poland	0.707	0.058	0.158	0.077
Spain	0.689	0.116	0.045	0.151
Hungary	0.677	0.143	0.073	0.107
United Kingdom	0.609	0.065	0.184	0.143
Japan	0.399	0.050	0.349	0.203
Country average	0.742	0.079	0.104	0.075

Source: Authors' calculations based on weighted data from REFLEX and HEGESCO.

Estimation and model specification

We estimate the determinants of mismatch using a multilevel multinomial logit model. We consider a three-level nested structure: individuals (i) are nested in fields of study (f), which are in turn nested in countries (c). Several models with the following general form are considered:

$$Y^k_{ifc} = X_{ifc}\beta^k_1 + F_{fc}\beta^k_2 + C_c\beta^k_3 + R^k_{ifc} + U^k_{fc} + V^k_c \quad (1)$$

where Y^k is a latent variable for mismatch category k (full match is the reference category), X is a vector of individual characteristics, F is a vector of field-of-study-level characteristics, C is a vector of country-level characteristics and R^k, U^k and V^k are level-specific error terms. The number of groups is 18 countries and 142 field-of-study segments.[5] While R^k, U^k and V^k are assumed to be random and thus independent from one another, we account for possible interdependence of errors within levels and across mismatch

[5] Within each country we delineate a maximum of eight fields of study: (1) education, (2) humanities and arts, (3) social sciences, business and law, (4) science, mathematics and computing, (5) engineering, manufacturing and construction, (6) agriculture and veterinary medicine, (7) health and welfare and (8) services. No observations of subject (8) were reported for Japan and Switzerland. Six individuals in the sample followed a general programme; these individuals are excluded.

categories.[6] We also estimate a standard binary logit model that groups the three mismatch categories into one category (i.e. match versus mismatch).

In order to assess how different types of variables explain the variance, we build our model iteratively. Model 0, our baseline model, only contains an intercept and the country-level random effect (V^k). In Model 1, we include covariates that are measured at the individual level (X). The covariates include a dummy for sex, the age of the graduate, a dummy for whether the graduate's degree provides access to a PhD programme[7] and relative study results within one's country.[8] Our Hypotheses 6 and 8 refer to within-country differences in the effect of study programmes. These can be related either to differences between fields of study or to differences between study programmes in the same field of study. To test the effect of study programme characteristics within fields of study, we include the deviation of the quality and selectivity of an individual's study programme from the average quality and selectivity of the study programmes of his/her field of study. We also include a similar variable with respect to the orientation (general versus specialized) of the study programme. These two variables are derived from a principal component analysis of the answers of respondents' assessments of six aspects of the content of their study programme (see Appendix table A1 for the factor loadings). The factor scores of the two extracted factors are used as proxies for the quality and relative orientation of the study programme.

In Model 2, we include the random effects at the level of field of study (R). Model 3 adds covariates that are measured at the field-of-study level (F). These covariates comprise seven field-of-study dummies (with Education as the reference category) and the deviations of the average quality and orientation of the study programme from country-level averages. Together with the aforementioned indicator of the quality/selectivity of study programmes within fields of study, this enables us to test Hypotheses 6 and 8. Moreover, by including field-of-study dummies as well as the orientation and quality/selectivity of fields of study within a country, we can assess whether differences in mismatches between humanities and technical degrees result from differences in study programme characteristics (Hypotheses 6 and 8) or from structural imbalances between the demand for and supply of labour trained in a particular field of study (Hypotheses 3 and 4).

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[6] The models are estimated using the *runmlwin* command implemented in Stata by Leckie and Charlton (2011) to fit multilevel models in the MLwiN software package (Rasbash et al., 2009).

[7] This broadly coincides with the distinction between bachelor's and master's programmes. Note, however, that the respondents of the REFLEX/HEGESCO survey completed their education before the Bologna process had harmonized tertiary qualifications in Europe, so the term bachelor or master is misleading.

[8] This last variable is based on the respondents' assessment of their grades in the year of graduation relative to other students. In the Japanese version, individuals were asked about their absolute grade, while in the other versions, respondents were asked about their relative grade. We construct a compatible variable by creating a standardized measure for Japanese and non-Japanese self-assessed performance. Missing values are imputed by their expected values using OLS regression.

In Model 4, we also account for country-level variables (*C*). First, to account for differences in educational institutions (Hypotheses 5 and 7), we include the average country scores for the quality/selectivity and orientation of the programme. Our measures of the structural supply and demand for skilled workers (cf. Hypothesis 1) are the share of highly educated individuals aged 25 or older — as measured by Barro and Lee (2001) — and gross domestic expenditure on R&D, as measured by the OECD (2008).[9] The (relative) structural oversupply of skilled workers is assessed by the difference between the standardized values of these two indicators. We also include the output gap – that is, the relative difference between actual and potential GDP – as an indicator of the business cycle (Hypothesis 2). This variable, developed by the OECD, is measured in the year of labour market entry (2000 or 2003, depending on the survey). We test Hypothesis 9 by using a composite measure of the overall strictness of EPL, also developed by the OECD (2004). To measure the generosity of unemployment benefits in a country, we include the replacement ratio (cf. Hypothesis 10). The replacement ratio is the proportion of expected income from work that is replaced by unemployment and related welfare benefits, as reported by the OECD (2010). Finally, for the measurement of collective bargaining coverage (cf. Hypothesis 11), we rely on data from Venn (2009).

Estimation results

Variance decomposition

In table 2 we report the variance decomposition yielded by the estimated multinomial logit models. Our baseline model (Model 0) indicates that the country level is responsible for 14 per cent of the overall variation in mere horizontal mismatch and 10 per cent of the overall variation in full mismatches across individuals. The country level is much less important in explaining the incidence of mere vertical mismatch. The residual country-level variance of mere vertical mismatch and full mismatch increases slightly when the individual-level variables are included (Model 1). The importance of country-level effects in explaining the incidence of mere vertical mismatch and full mismatch thus appears to be somewhat underestimated due to compositional effects. The opposite seems true for mere horizontal mismatch. In Model 2, we also include the random effects at the field-of-study level. The field of study is found to be a significant driver of full mismatch (13 per cent of the overall variance), but somewhat less important in explaining mere vertical mismatch (5 per cent) and mere horizontal mismatch (6 per cent). When field-of-study-level variables are included as well (Model 3), the unexplained field-of-study-level variance is largely eliminated for full and mere horizontal mismatch. In the case of mere vertical mismatch, however, an unexplained field-of-study-level variance of 3.4 per cent remains. Factors other than field-of-study and programme

[9] Both measures are based on data for the year 2000. Because of missing information, the R&D expenditures of Norway are for the year 2001.

Table 2. Variance decomposition under alternative model specifications

	Model 0	Model 1	Model 2	Model 3	Model 4
Model specification					
Individual level variables	No	Yes	Yes	Yes	Yes
Field-of-study level variables	No	No	No	Yes	Yes
Country level variables	No	No	No	No	Yes
Field-of-study level random effect	No	No	Yes	Yes	Yes
Country level random effect	Yes	Yes	Yes	Yes	Yes
Variance decomposition of mere VMM					
Unexplained var. individual level	0.977	0.899	0.867	0.864	0.871
Unexplained var. field-of-study level			0.047	0.034	0.034
Unexplained var. country level	0.023	0.024	0.018	0.019	0.001
Explained variance		0.078	0.067	0.083	0.094
Variance decomposition of mere HMM					
Unexplained var. individual level	0.862	0.846	0.819	0.795	0.771
Unexplained var. field-of-study level			0.064	0.007	0.008
Unexplained var. country level	0.138	0.112	0.071	0.081	0.011
Explained variance		0.042	0.046	0.116	0.209
Variance decomposition of full MM					
Unexplained var. individual level	0.901	0.808	0.749	0.744	0.736
Unexplained var. field-of-study level			0.126	0.016	0.012
Unexplained var. country level	0.099	0.109	0.054	0.075	0.014
Explained variance		0.082	0.071	0.165	0.238

Source: Authors' calculations based on REFLEX and HEGESCO data.

characteristics are thus responsible for differences in mere vertical mismatch across fields of study. Also interesting is the change in the unexplained country-level variance after including field-of-study-level variables and random effects (Model 1 versus Model 3). This unexplained variance drops substantially both for mere horizontal mismatch and for full mismatch (from 11 to 8 per cent in both cases). This indicates that a substantial part of cross-country variation can be attributed to differences in the extent to which graduates within countries enroll in fields of study that are associated with low mismatch probabilities. Finally, in Model 4, we also include the variables that are measured at the country level. This largely eliminates the unexplained gross variation between countries for all types of mismatch.

Main estimation results

Table 3 presents the estimation results for the full multinomial logit model specification (Model 4).[10] The binary logit model results on the likelihood to have any type of mismatch are not reported in detail, but are available upon

[10] To save space, we do not report the estimation results for the other specifications. These results are available from the authors upon request.

Table 3. Probability of mismatch five years after graduation – multinomial logit multilevel coefficient estimates – full model specification (Reference = Full Match)

	Mere VMM	Mere HMM	Full MM
Constant	–2.261***	–0.232	–2.110***
Level 1 variables: Individuals			
Female	0.133**	0.042	0.157**
Age	0.020***	–0.005	0.019***
Degree not providing access to PhD	–0.848***	0.202***	–0.101
Relative study results	–0.206***	–0.052*	–0.156***
Quality and selectivity: deviation from study field average (a_1)	–0.305***	–0.454***	–0.611***
General orientation: deviation from study field average (b_1)	–0.040	0.152***	0.023
Level 2 variables: Fields of study			
Quality and selectivity: dev. from country average (a_2)	–0.644***	–0.343**	–1.248***
General orientation: deviation from country average (b_2)	–0.383*	0.365*	–0.217
Field of study (Ref = Engineering, Manufacturing and Constr.)			
Education	–0.814***	0.113	0.056
Humanities and Arts	–0.253	0.654***	0.993***
Social sciences, Business and Law	–0.384**	0.328**	0.364**
Science, Mathematics and Computing	–0.213	0.221	0.492***
Agriculture and Veterinary	–0.293*	0.521***	0.576**
Health and Welfare	–0.552**	–0.763***	–0.232
Services	–0.528**	0.726***	0.494**
Level 3 variables: Countries			
Quality and selectivity: country average (a_3)	–0.184	–1.820***	–0.721**
General orientation: country average (b_3)	0.023	–0.116	0.538*
Structural imbalance supply and demand of skilled workers	0.408***	0.004	0.565***
Output gap at labour market entry	–0.178***	0.034	–0.361***
Replacement ratio	–0.172	–2.116**	–1.169
Degree of employment protection	–0.334	–0.343*	–0.369
Collective bargaining coverage	0.477	–0.084	0.876**
Chi² statistics			
Chi² ($a_1 = a_3$)	0.30	24.37***	0.12
Chi² ($b_1 = b_3$)	0.01	0.94	2.92*
Chi² ($a_2 = a_3$)	2.72*	21.88***	2.20
Chi² ($b_2 = b_3$)	1.56	2.15	4.41**
Variance–Covariance matrix random effects			
Level 2: var(A), var (B), var(C)	0.127***	0.035*	0.062**
Level 2: cov(A,B), cov(B,C), cov(A,C)	–0.022	0.043**	0.031*
Level 3: var(A), var(B), var(C)	0.003	0.048**	0.053*
Level 3: cov(A,B), cov(B,C), cov(A,C)	–0.033**	–0.006	0.028

Notes: * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$. N = 14398.
Source: Authors' calculations based on REFLEX and HEGESCO data.

request. Before we turn to the variables of interest, we first briefly describe the other results. Regarding the variance-covariance matrix of our model, we find that most variances remain statistically significant. Including random effects is thus justified. Further, our covariance estimates do indeed suggest some interdependence between mismatch categories.

With respect to the individual-level characteristics, we are primarily interested in the impact of study-programme characteristics on mismatch. Our results support the hypothesis that individuals who graduate from a study programme that is of above-average quality are less likely to experience a mere vertical or full mismatch in their current job (Hypothesis 6). Our estimates also show that study-programme quality has a negative effect on the likelihood that a graduate will experience a horizontal mismatch. Our results with respect to the relative orientation of the study programme are only partially in line with Hypothesis 8. Individuals graduating from a relatively general study programme are more likely to be merely horizontally mismatched. However, we do not find statistically significant evidence regarding the likelihood of full mismatch. As for the other individual characteristics, we find that females and older graduates have a higher likelihood of being merely vertically mismatched or fully mismatched. Also, individuals holding a degree that does not provide access to a PhD programme show a lower probability of being merely vertically mismatched, but a higher probability of being merely horizontally mismatched. Finally, we find that individuals with better study results have a higher likelihood of finding a good match five years after graduation. This result mirrors our findings on the quality/selectivity of the study programme; any variable suggesting a low quality of human capital increases an individual's risk of all types of mismatch.

Our results regarding the programme characteristics measured at the field-of-study level corroborate the important role played by signals of quality of human capital. Graduates from fields of study with relatively more selective and higher quality programmes exhibit a lower incidence of all types of mismatch. We further find that graduating from a relatively general study programme increases the likelihood of experiencing a mere horizontal mismatch. Study programme orientation does not have a statistically significant effect on the incidence of full mismatch. However, our results also indicate that graduates in fields of study with a general study programme face a lower incidence of mere vertical mismatch. Finally, our results show that individuals with humanities and arts degrees have the highest likelihood of a full mismatch, and rank second and third of all fields of study in terms of mere horizontal and mere vertical mismatch, respectively.[11] This seems largely in line with Hypothesis 4. However, our hypothesis regarding graduates with a technical degree (Hypothesis 3) is not supported. We indeed find that, conditional on the

[11] The difference is statistically significant ($p < 0.10$) in comparison to all other fields of study for full mismatches and in comparison to six of the eight fields of study for mere horizontal mismatches. However, regarding mere vertical mismatch, only the difference with education turns out to be statistically significant.

orientation and quality of the study programme, graduates with a degree in engineering, manufacturing or construction are relatively less likely to have a full mismatch (five of the other seven fields of study perform significantly worse; the other two have a statistically indistinguishable likelihood of full mismatch). These graduates' likelihood of a mere horizontal mismatch is relatively low, although graduates with a health and welfare degree fare significantly better in this respect. However, graduates from engineering fields of study are significantly more likely (than those in five of the other seven fields of study) to have a mere vertical mismatch. Moreover, for graduates in science, mathematics and computing, we find an increased incidence of full mismatches. The unreported binary logit results on the likelihood of any type of mismatch reject Hypothesis 3: while graduates with an engineering, manufacturing or construction degree perform significantly better on this outcome compared to those with a humanities or arts degree, they also perform significantly worse than those with an education degree or a health and welfare degree. To assess the extent to which these outcomes can be attributed to the fact that we account for the average quality and orientation of programmes in each field of study, we also estimated a reduced-form model that excludes these study programme variables.[12] Differences in mere vertical mismatch across fields of study are much less pronounced if we do not control for these characteristics. Nevertheless, this specification still finds that engineering, manufacturing and construction graduates face a higher probability of mere vertical mismatch than education and health and welfare graduates.

Also at the country level, we find that human capital quality/selectivity is an important predictor of mismatches. The likelihood of full mismatch or mere horizontal mismatch is lower for individuals in countries with more selective and higher quality educational systems (Hypothesis 5). Regarding mere horizontal mismatch, this between-country effect is even more pronounced than the within-country effects. The opposite seems to be true regarding mere vertical mismatch, as we do not find any evidence that the quality/selectivity of the educational system at the country-level affects this type of mismatch. However, some caution is recommended regarding this conclusion; the difference between the country-level and field-of-study-level effects is only statistically significant at the 10 per cent level. With respect to the orientation of the educational system in each country, we note some differences between the within-country effects and the between-country effect. Countries with a more generally oriented system show a higher incidence of full mismatch. Although this outcome supports Hypothesis 7, we do not find any statistically significant evidence for mere horizontal mismatch.

Besides these two characteristics of the educational system, we distinguish two other groups of country-level factors: the supply and demand context and labour market institutions. Our results indicate that countries that face a structural oversupply of skilled workers have a higher incidence of

[12] To save space, the results are not reported here, but they are available upon request.

Table 4. Probability of mismatch five years after graduation - multinomial logit multilevel coefficient estimates – reduced model specification (Ref = Full Match)

	Mere VMM	Mere HMM	Full MM
Level 3 variables: Countries			
Quality and selectivity: country average	—	–1.894**	–0.613**
General orientation: country average	—	—	0.676**
Structural imbalance demand and supply of skilled workers	0.404***	—	0.583***
Output gap at labour market entry	–0.181***	—	–0.412***
Replacement ratio	—	–1.596**	—
Degree of employment protection	–0.330**	–0.389**	–0.489**
Collective bargaining coverage	0.430**	—	0.949**

Notes: Included but not reported variables at level 1 and 2: see table 3. * p < 0.10. ** p < 0.05. *** p < 0.01. N = 14398.
Source: Authors' calculations based on REFLEX and HEGESCO data.

mere vertical and full mismatch (Hypothesis 1). The reverse is true for countries experiencing an economic upswing, as measured by a positive output gap (Hypothesis 2). We find that neither type of imbalance has a significant impact on mere horizontal mismatch. The outcomes with respect to EPL and unemployment benefits are only partially in line with our predictions. As expected, we find that a higher level of employment protection and higher replacement ratios are both associated with a lower incidence of mere horizontal mismatch (Hypotheses 9 and 10), though their estimated effects on the other two types of mismatch are statistically insignificant. The unreported results of the binary logit analysis reveal that employment protection has a statistically significant ($p < 0.10$) impact on the likelihood of full match. Finally, collective bargaining coverage has a significantly positive effect on the likelihood of full mismatch (Hypothesis 11), but it has no statistically significant effect on the likelihood of mere horizontal or mere vertical mismatch.

Sensitivity analyses

Given that a few pairs of country-level variables have substantial correlations,[13] some of the results may be responsive to the inclusion of other variables. As a sensitivity test, we therefore also estimate a reduced model based on stepwise backward elimination of insignificant country-level variables.[14] Table 4 presents the results obtained from this analysis. All of the results regarding the supply and demand context, the characteristics of the educational system

[13] These correlations are available upon request.

[14] In another sensitivity test, we re-estimated our full model specification omitting the data from Japan. Compared to other countries, Japan shows a substantially higher incidence of mere horizontal mismatches (see table 1). Yet the only changes in results were some differences with regard to the impact of educational system characteristics. We did not find that the quality/selectivity of the educational system or its orientation had a statistically significant impact on the incidence of full mismatch. These estimation results are available upon request.

and the replacement ratio are consistent with the outcomes of our full model. However, there are some clear differences with respect to EPL and collective bargaining coverage. While the full model found that EPL only had a significant impact on mere horizontal mismatch, the reduced model suggests that it also has significant positive effects on the other two types of mismatch. The reduced model also shows that collective bargaining coverage has a statistically significant effect on mere vertical mismatch (Hypothesis 11).

Discussion and conclusion

This study was designed to determine what explains country and field-of-study differences in educational mismatches five years after graduation. In contrast to other studies, we analysed horizontal and vertical mismatches simultaneously, defining three mismatch categories: mere vertical mismatch, mere horizontal mismatch, and full mismatch. We investigated three types of explanatory factors: those related to the demand and supply context, educational institutions and labour market institutions.

Regarding the demand and supply context, we find that both cyclical and structural country-level imbalances drive the incidence of mere vertical and full mismatch, but not mere horizontal mismatch. The observed effect of these imbalances on over-education is in line with the outcomes of several other studies, confirming that graduates are prepared to accept lower-level positions when they face difficulties finding jobs that match their level of education. Further, the absence of an effect of these imbalances on mere horizontal mismatch suggests that the positive effect resulting from graduates' increased willingness to accept such positions is offset by an equally large negative effect resulting from an increase in employers' selectivity (cf. Bowlus, 1995).

Differences in mismatch patterns between fields of study also seem to be explained by imbalances between demand and supply. In particular, graduates with an arts and humanities degree are more likely to experience any type of mismatch. Given that these higher incidences remain even after accounting for differences in the selectivity and orientation of the study programmes, the cause of this negative labour market performance appears to be at least partly quantitative—that is, labour supply outstrips the demand for graduates with arts and humanities qualifications. Graduates with a technical degree are less likely to experience a mere horizontal or full mismatch. However, after accounting for the selectivity and the rather specialized orientation of study programmes in technical fields of study, we find that graduates of these programmes are more likely to experience a mere vertical mismatch than graduates from most other fields of study. This suggests that the shortage of jobseekers with a technical education is mainly concentrated at more intermediate and undergraduate levels. Still, this requires further investigation.

Concerning educational characteristics, we first consider the quality and selectivity of study programmes. Within countries, we find that a lower quality and selectivity of the study programme increases graduates' likelihood of

experiencing any type of mismatch. A record of lower grades has the same effect. The finding that individuals with lower-quality human capital are more likely to be over-educated for their job was expected, and fits with the conclusions of many earlier studies. However, the effect on mere horizontal mismatch was not anticipated and does not support the idea that a mere horizontal mismatch is a less severe problem because it signals higher employability. It may be that employers hire these graduates due to a shortage of candidates with a matching field of study. Also, in terms of the differences in mismatch between countries, we find evidence that the quality and selectivity of the educational system matters. Contrary to our expectations, however, we find no evidence of country-level effects on mere vertical mismatch. One explanation may be that our quality indicator insufficiently captures quality differences across countries if individuals base the assessment of the quality of their study programme only on a within-country comparison. If so, however, we would not expect to find that country-level average quality has an effect on the other two types of mismatch either. An alternative explanation may be provided by the subjective nature of our over-education measure. To the extent that the overall quality of the educational system is perceived to be poor, individuals may inflate their assessment of what is required to do their job. In other words, improving the overall quality of the educational system may result in less formal over-education, but not in less genuine over-education (cf. Chevalier, 2003). Further evidence, relying on more objective indicators, may resolve this.

Our results with respect to the orientation of the educational system are less straightforward. Looking at differences within countries, we find that a general orientation increases the incidence of mere horizontal mismatch. But looking at differences between countries, a general orientation increases the incidence of full mismatch. These effects were expected, since general programmes may provide more skills that can be used across occupations. However, our results did not reveal a similar within-country effect on full mismatch or a similar between-country effect on mere horizontal mismatch. With respect to mere vertical mismatch, we find an unanticipated negative within-country effect. This suggests that although graduates with a general education are more prone to horizontal mismatch, they are not more likely to be over-educated for their job. This might be explained as follows: if graduates cannot find a job that matches their education, those with a general education are more likely to switch to jobs outside their field of study than those with a vocational education. The implication may be that these generally educated graduates must start their career in a position below their level of education, but they are more often promoted to a higher position after several years.[15]

Labour market institutions play an important role in determining cross-country differences in mismatches as well. First, we find that strict EPL

[15] Unreported estimates on match status in the first job after graduation are consistent with this interpretation. We find no significant within-country effect of general study programmes on mere vertical mismatch and a significantly positive within-country effect on mere horizontal and full mismatch. These estimates are available upon request.

reduces the incidence of mere horizontal mismatch five years after graduation. This fits with the expectation that employers are reluctant to hire graduates from non-matching fields of study since these individuals do not provide any reliable signal regarding their productivity. After all, dismissal will be difficult or costly if the result of the screening process turns out to be negative. We expected that in countries with strong EPL, employers would rely more on internal promotions, thus increasing the likelihood of mere vertical mismatches. However, this was not confirmed by our analyses. It may be the case that employers also perceive employment of merely vertically mismatched individuals to be risky. Individuals may become dissatisfied with their job if they are not promoted (see Béduwé and Giret, 2011), resulting in demotivation and lower productivity. It is noteworthy that our findings on mere vertical mismatch differ from those of other studies, including Di Pietro (2002), Croce and Ghignoni (2012) and Verhaest and van der Velden (2013). A possible explanation is that these other studies focus on the full labour force. To the extent that individuals cannot be fired after organizational and technological changes, the quality of jobs matching may be poorer among older employees than among younger employees. Another explanation is that these studies may not account for other labour market institutions that are correlated with EPL, such as unemployment benefits and collective bargaining coverage.

Our findings are also novel with regard to the effects of the generosity of the unemployment benefit system and collective bargaining coverage. We find that a higher replacement ratio decreases the country-level incidence of mere horizontal mismatches five years after graduation. This suggests that higher unemployment benefits allow jobseekers to be more selective. We also find that higher bargaining coverage results in a higher incidence of full mismatch. This conforms with the results of Croce and Ghignoni (2012) and can result both from downward wage rigidity in skilled jobs and from wage compression. The finding that collective bargaining coverage has no impact on the incidence of horizontal mismatches suggests that the positive effect of wage rigidity, which prevents demand from adapting to supply, is compensated by the negative effect of wage compression, resulting in a lower willingness among job seekers to take jobs outside their field of study.

In sum, our study shows that differences in educational mismatches across countries and fields of study are driven by a broad range of mechanisms. This creates a clear policy challenge as it indicates that a combination of economic, education and labour market policies may be needed if mismatch among young workers is to be reduced. This is particularly true of full mismatches, which can be considered the most problematic. A first policy measure may be to invest in the quality of the study programmes. The provision of study-choice guidance and information regarding the fields of study most in demand on the labour market may also be helpful in reducing mismatches. Furthermore, governments could increase financial support for R&D investments (see also Ghignoni and Verashchagina, 2014), which may in turn increase overall demand for graduates and reduce possible structural imbalances.

While such measures may be rather uncontroversial, others may conflict with alternative priorities, such as combating youth unemployment. Increasing unemployment benefits, for instance, may well help young people to find jobs that match their field of study. However, it might also reduce their incentive to search for a job. Similarly, while we found strong EPL to be associated with lower incidences of mismatch, stronger EPL may also increase the bargaining power of insiders on the labour market, thereby reducing graduates' chances of finding a job in the first place. Further research would indeed be helpful in providing more insight into these issues.

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Appendix

Table A1. Derivation of the quality and selectivity and the general orientation of the study programme: Principal components rotated factor loadings

To what extent did the following descriptions apply to your study programme	Component 1: Quality and selectivity	Component 2: General orientation
Programme was generally regarded as demanding	.365	.113
Employers are familiar with the content of programme	.430	–.092
There was freedom in composing your own programme	–.179	.587
Programme had a broad focus	.016	.501
Programme was vocationally orientated	.407	–.207
Programme was academically prestigious	.282	.299